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Some Measurement Problems in Comparing US and USSR Industrial Labor Productivity*

Dr. Gertrude Schroeder
US Bureau of the Census

The comparison of productivity between countries presents difficult conceptual and methodological problems. Nevertheless, economists persist in trying to surmount these difficulties, because comparative productivities show how effectively at any given moment different countries are using their productive resources (capital and labor) and how this relative effectiveness has changed over time. This paper will consider some of the more important methodological problems involved in international comparisons of productivity in industry as measured by output per unit of labor. I leave to others the problems of measuring comparative productivity in the non-industrial sectors of the economy, of computing capital inputs, and of combining labor and capital measurements into a measurement of "total" productivity. After outlining the methodological problems, I shall illustrate them by drawing on some of the comparisons of industrial labor productivity in the US and the USSR recently made by Soviet and Western economists and on a few comparisons of my own.

General Methodological Problems

International comparisons of relative levels of industrial labor productivity may be approached in two general ways. The first, which may be termed the "price index" approach, is to measure the value of the aggregate product per unit of labor originating in industry in each country expressed in the currencies

of both countries. The procedure, in essence, would be first to value the gross products in the two countries in each other's currencies and then to deduct the cost of materials inputs valued in the same way to obtain a measure of net output, or "value added" in Western terminology. The principal methodological problems would be those involved in ensuring that outputs and inputs are defined and measured in the same way for both countries. Because the data problems involved in this approach are so formidable, investigators have had to resort to the second approach, which may be termed the "quantity index" approach. In essence, this method is to measure the physical output per unit of labor for as many equivalent products as possible and then to aggregate the results with value-added weights.

Both of these approaches yield measures of labor productivity by branch of industry, telling us much about the differences in industrial structure in the two countries and showing us how these differences affect overall productivity levels. Important methodological problems are common to both approaches. [1] First, there is the matter of the size and representativeness of the sample. When comparisons are made between a relatively advanced country and one considerably less so, there are likely to be many unique goods in the production pattern of the former, for which no meaningful price or quantity can be found in the latter. If the sample is not to be seriously biased, techniques must be devised to convert most of these unique products into equivalent products. If unique products predominate, an aggregate comparison probably should not be attempted.

Next, there arise the problems connected with differences in product quality. Where products are similar in name but different in quality in the

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[1] The problems of comparisons of national products between countries are discussed in detail in Milton Gilbert and Irving B. Kravis, An International Comparison of National Products and the Purchasing Power of Currencies, O.E.E.C., Paris, 1954.

two countries, means for adjusting for these differences must be devised, for goods of higher quality represent more "product" in an economic sense than goods of lower quality, because the former require the expenditure of additional resources to produce them. In Country A, for example, a typical "automobile" may weigh 3,000 pounds and be equipped with automatic transmission, whereas in Country B an "automobile" may weigh 2,000 pounds and have manual transmission. Clearly, more resources would be required to produce the heavier automobile in both markets, so that an "automobile" is not a homogeneous product between the two countries. The methodological problem, then, is to devise ways to convert such products into homogeneous units -- that is, into equivalent products. Although the particular techniques will differ depending on product peculiarities and available data, the aim must be to measure as best we can the proportionate adjustment in costs or prices that would result in the two countries if identical products were made.

Having selected our measure of output and our sample of comparable products, we next must consider the choice of the weights to be used to aggregate individual products into branches of industry and to sum the branches. We may use physical weights, e.g., employment, as did Rostas and Frankel in their investigations of labor productivity in British and American industry. 1/ Or we may compute factor cost weights, as did O.E.E.C. economists in their pioneering effort to compare output and productivity in the US and the UK by sector of origin. 2/ For aggregate productivity comparisons the objective should be to obtain the closest possible approximation to net output weights.

1/ L. Rostas, Comparative Productivity in British and American Industry, Cambridge University Press, Cambridge, 1948.
     M. Frankel, British and American Manufacturing Productivity, University of Illinois, Urbana, 1957.
2/ Deborah Paige and Gottfried Bombach, A Comparison of National Product and Productivity of the United Kingdom and the United States, O.E.E.C., Paris, 1959.

Often, however, the choice of weights is limited both by the data available and by the time and resources at the disposal of the investigator.

The necessity for weighting produces the famous "index number problem," on which statisticians have expounded at length. The question here is merely which country's employment or prices shall be used as weights, those of either country being equally valid conceptually. Or shall we calculate an average of the two results, and if we do, what is its economic meaning? Until someone "solves" the index number problem, we shall have to continue to present both results -- or even all three -- in making statements about comparative productivity.

Having surveyed briefly some of the problems involved in measuring the numerator of the labor productivity ratio, I now turn to a consideration of the denominator. The main conceptual problem is that of selecting a measure of labor input that is consistent with the measure of output. Depending on our purposes, we may divide the industrial output measures by the total number of persons employed, production workers, man-year equivalents, or manhours. We might even try to adjust the employment measures in some way to allow for differences in skill levels (i.e., quality). With the employment measure chosen, the methodological problems are mainly those of wrestling with the data, both to ensure comparability with the product data and to make appropriate adjustments for differences between countries in the concepts and measurements used to compile employment statistics.

My final point on general methodology concerns the indexes appropriate for extending the base-year findings concerning relative levels forward or backward in time. Clearly, the productivity indexes used for this purpose ought to be comparable between countries and conceptually consistent with

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the measures used to estimate relative productivity levels in the given year. Thus, if we have measured net product per person employed in the two countries, the productivity indexes used for extrapolation should measure changes in this same magnitude by comparable procedures for both countries.

The making of valid international productivity comparisons surely is one of the most difficult statistical tasks that one can undertake. The data problems are always of monumental proportions, and compromises with conceptual and methodological ideals constantly have to be made. The task is particularly difficult when one tries to compare productivity in market and non-market economies, such as the US and the USSR. I turn now to consider how some recent practitioners of the art of international comparisons have tried to surmount the difficulties.

Comparisons Made by Soviet Economists

During the past several years Soviet economists have published a number of comparisons of trends and levels of labor productivity in the US and the USSR. Their comparisons for industry as a whole are most interesting and could tell us much about how Soviet scholars have tried to resolve the extremely complex methodological problems involved in comparing economies with such different industrial structures, product mix, and institutional settings as the US and the USSR. Unfortunately, however, the authors have not provided detailed descriptions of these methodologies or the basic data from which an independent reconstruction of their results could be made. I shall review these comparisons briefly, making such comments on concept and methodology as are feasible.

The first of these overall comparisons, made by Ya. Ioffe, was published in 1957 and showed Soviet labor productivity in 1955 to be 40-42 percent of the US. [1] He later published the following comparisons (US = 100): [2]

	1955	1956	1957	1958	1959
Output per person employed	40	42	44	45	46
Output per production worker	44	46	48	49	51

Another economist, A. Aganbegyan, has published the finding that in 1957 Soviet output per person employed was half that of the US. [3]

The overall comparisons currently cited most often in Soviet literature and used in statistical handbooks [4], however, are ones recently presented by V. Starovskiy. [5] The author states that he calculated both the gross and the net value of industrial production in the two countries in 1959, using ruble-dollar ratios calculated on the basis of both the Soviet product mix and the US product mix. He found that the gross value of industrial production in the USSR was 60 percent of the US in both rubles and dollars and that the net value was 61 percent when measured in rubles and 60 percent when measured in dollars. With respect to labor productivity, he states "proceeding from these data (industrial production in the USSR more than half, and production workers about 30 percent more than in the US), we conclude that the productivity of industrial workers in the USSR in 1959 was 40-50 percent of industrial labor productivity in the US." [6]

Soviet economists undoubtedly spent many laborious hours in constructing these comparisons, and they may have made important progress in solving some of the difficult methodological problems of international comparisons. I feel

[1] Strany sotsializma i kapitalizma v tsifrakh, Moscow, 1957, p. 59.
[2] Planovoye khozyaystvo, No 3, 1960, p. 48.
[3] Sotsialisticheskiy trud, No 4, 1959, p. 19.
[4] Narodnoye khozyaystvo SSSR v 1959 godu, Moscow, 1960, p. 89.
[5] SSSR - SShA, tsifry i fakty, Moscow, 1961, p. 29.
[6] Ibid., p. 112.

we would all benefit immensely from a detailed exposition of the methods
and data used. In particular, we need to know the items included in the
sample, the individual product comparisons that were made, the kind of
weights employed to aggregate these products, and the details of the adjust-
ment of employment data for comparability.

I would like to make only two comments, which bear on two of the methodo-
logical dilemmas previously discussed -- the index number problem and the
problem of the temporal extrapolation of findings concerning relative productivity
levels in a given year. My first comment concerns Starovskiy's conclusions
regarding output levels. Leaving aside the unanswered question of how "gross"
and "net" output were defined and compared in the two countries, I find his results
most puzzling, and I wonder if there may have been some miscalculation. The
finding that the relative levels of "net" output are the same regardless of
which country's prices are used implies that the price structures (or product
mix) in the two economies are essentially the same (or that the differences
are offsetting) -- a situation that seems highly improbable theoretically
and also is at variance with the findings of ruble-dollar ratio studies made
by American economists. 1/ In addition, the conclusion that Soviet output
relative to the US is higher when both outputs are valued in rubles differs
from the results of international product comparisons made for Western
economies, where a given country's level of output invariably was found to
be considerably higher relative to the level in another country when both
outputs are measured in the other country's prices. One would suppose that
this general result should obtain also for comparisons of total industrial
production in the US and the USSR.

1/ A. S. Becker, Prices of Producers' Durables in the United States and the
USSR in 1955, RAND, RM 2432, August 15, 1959.
        Norman H. Kaplan and Eleanor S. Weinstein, A Comparison of Soviet and
American Retail Prices, RAND, P-2078, October 1956.

My second point concerns the authors' extrapolations of their findings regarding productivity levels in a base year. Apparently, all three Soviet authors used the official industrial production index for the USSR and the Federal Reserve Board's index of industrial production for the US. The employment indexes presumably are the official Soviet index and an index for the US based on Bureau of Labor Statistics data. But neither the production indexes nor the employment indexes are really comparable. The US production index measures changes in net output (value-added) in manufacturing, mining, and electric and gas utilities. The Soviet index measures changes in the gross value of output in "industry," defined to include a number of activities not covered by the US index. A similar definitional problem arises with respect to the coverage of the two employment indexes. The inconsistencies that result from the use of these indexes to extrapolate the findings of cross-section productivity studies may best be shown, perhaps, with an example. Before the War, Soviet economists estimated that Soviet industrial labor productivity in 1937 was 40.5 percent of the US level. [1] If this ratio is extended to 1958 by use of the two productivity indexes described above, the ratio for 1958 would be over 80 percent; current Soviet cross-section studies find it to be 40 to 50 percent.

Soviet economists also have recently published several investigations of relative levels of labor productivity in individual branches of industry. The most comprehensive of these is A. Kats' comparison of physical output per production worker for 28 branches of industry in the US in 1954 and the USSR in 1956. [2] The author claims that these branches represent about two-fifths

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[1] Planovoye khozyaystvo, No 3, 1939, p. 153.
Ya. A. Ioffe (compiler), SSSR i kapitalisticheskiye strany, Gosplanizdat, Moscow, 1939, p. 77.
[2] Sotsialisticheskiy trud, No 1, 1959, pp. 42-55.

of total production workers and production worker payrolls in the USSR. According to Kats' comparisons, labor productivity in the USSR ranged from 17.1 percent of the US for margarine to 147.4 percent for bread and bakery products, the average being 45.4 percent when weighted by USSR payrolls and 47.9 percent when weighted by USSR employment. Although the sample covered a wide variety of industries, all but one product of the machine building industry was omitted, as were non-ferrous metallurgy, electric power and most of the chemicals industry. To adjust Soviet employment data to the US definition of production workers, Kats added apprentices, guards, and junior service personnel to wage workers (rabochiye) for the USSR. In a later paper, Kats reported (with no details) his findings that physical output per production worker for 25 branches of industry in the USSR in 1957 averaged 42-47 percent of the US in 1956. 1/

Several other Soviet investigations of comparative labor productivity in particular industries were published in 1959 and 1960. Two of the studies pertain to the machine building industry. In the first of these the authors computed measures of productivity in specialized machine tool plants in the USSR in 1958 and in all machine tool plants in the US in 1956. 2/ The authors found Soviet output per production worker to be 60.5 percent of the US computed in physical units and 53.7 percent computed in "standard" units. The second of the two studies compared relative levels of output and productivity in the machinery and metalworking industry as a whole. 3/ Using value indicators of some kind, the authors concluded that Soviet output in 1958 was 40-44 percent of the US and that output per production worker was 33-37 percent of the US. Finally, without presenting methodological details, A. Aganbegyan claims that Soviet labor productivity (presumably output per production worker

1/ Ekonomicheskiye nauki, No 1, 1961, p. 132.
2/ Vestnik statistiki, No 6, 1960, pp. 25-32.
3/ Planovoye khozyaystvo, No 1960, pp. 81-91.

in 1957) was 40 percent or less of the US level in mining (25 percent in coal mining), logging, and the chemical industries; the levels were 50-67 percent in machine building, metallurgy, light industry, and the food industry. [1]

Again, the reader of these studies for particular industries is handicapped by a lack of knowledge of the data and the methodological detail underlying the results. For example, although Kats' investigation appears to be a careful effort to obtain comparability, I was unable to reproduce many of his figures for the US. I question also whether such heterogeneous product categories as "metal-cutting machine tools," "bread and bakery products," and "confecti nery products" should be compared in physical units (i.e., number of tools or tons). Here, it would seem necessary to allow for quality differences in some way.

Comparisons Made by US Economists

Three Western estimates of the relative levels of total industrial production and productivity in the two countries have been published recently, all of them in papers or testimony presented before Committees of the US Congress. Two of these studies were made by US Government economists. The earlier study found that both production and productivity in the Soviet Union in 1955 were about one-third of the US. [2] The later one found that the level of production in the USSR in 1958 was about two-fifths of the US, and the level of labor productivity was about one-third. [3] Unfortunately, these two estimates present us with the same problem as do those made by Soviet economists -- that is, the authors tell us neither how the figures were obtained, nor even what they mean, i.e., are the relatives in rubles or dollars or do they represent geometric means? The author of the third of these studies, G. Warren Nutter,

[1] Sotsialisticheskiy trud, No 4, 1959, p. 15.
[2] US Congress, Joint Economic Committee, Soviet Economic Growth: A Comparison with the United States, (85th Congress, 1st Session), Washington, 1957, p. 105.
[3] US Congress, Hearings Before the Joint Economic Committee, Comparisons of the United States and Soviet Economies, (86th Congress, 1st Session), Washington, 1960, p. 4.

concludes that Soviet output was 22.7 percent of the US in 1955 and that productivity was 20.7 percent. 1/ These are value measures of some kind, but just what kind remains obscure. Nutter's estimates also raise serious questions of comparability, because his measures clearly omit military production and a substantial part of machinery on the Soviet side, but include them for the US. American economists have taken Nutter to task on the matter of comparability. 2/

The US Bureau of the Census has recently completed several comparative productivity investigations in the logging, automobile, and mineral fuels industries. The authors of these studies made numerous adjustments in both production and employment data for the two countries in an effort to obtain comparability. The data and methodologies are spelled out in detail in the published studies. For logging the average physical output per production worker manday in the USSR in 1956 was found to be 18 percent of the US. 3/ For the automobile industry the gross value of output per production worker in the USSR in 1955 was shown to be 38 percent (measured in dollars) of that of the US in 1954. 4/ For the mineral fuels industries, Demitri Shimkin obtained the following productivity ratios measured in standard fuel equivalents per person employed for the US in 1954 and the USSR in 1955: coal and lignite extraction - 19 percent; coke - 34 percent; oil and gas extraction - 19 percent; and oil and gas refining - 36 percent. 5/ Shimkin's study, which also obtained productivity ratios for 1939-40, includes some interesting materials

1/ US Congress, Joint Economic Committee, Comparisons of the United States and Soviet Economies, Joint Committee Print, (86th Congress, 1st Session), Washington, 1959, Part I, p. 113.
2/ R. V. Greenslade and Phyllis A. Wallace, "Industrial Growth in the Soviet Union: Comment," American Economic Review, September 1959, pp. 687-95.
3/ US Bureau of the Census, International Population Reports, Series P-95, No 54, September 1959, p. 93.
4/ US Bureau of the Census, International Population Reports, Series P-95, No 53, June 1959, p. 109.
5/ US Bureau of the Census, International Population Reports, Series P-95, No ___ (forthcoming).

that illustrate the problems involved in the choice of weights. Experimenting with employment and price weights for both countries, he found that Soviet output of mineral fuels in 1955 ranged from 22 percent to 75 percent of the US in 1954, depending on the weights. He elected to use an unweighted average (32 percent).

To illustrate the difficult problems faced by Western scholars in comparing US-USSR productivity, I have attempted a few comparisons, which are shown in Appendix Tables 1 - 4. Productivity is measured by physical output per production worker in 1956 for both countries. The resulting ratios are generally lower than those obtained by Kats, whose comparisons, however, were for the US in 1954 and the USSR in 1956. In some cases the reasons for the differences are clear; in others they are not. We may examine the comparisons by reference to the major methodological problems posed at the outset. First, with respect to the nature of the sample, the comparisons cover 26 branches of industry employing 26 percent of all production workers in the US and 35 percent of this total in the USSR. [1] The sample includes every product measurable in physical units for which reasonably comparable output and employment data could be found for the two countries. A major restriction on the size of the sample was the absence of employment data for the USSR. Lack of data also prevented allowance for differences in coverage and specialization ratios for individual branches of industry in both countries. No account had to be taken of unique products, because the sample is limited to relatively simple, homogeneous and mass-produced goods. Thus, the sample leaves out nearly all the metalworking and chemicals industries, where unique products abound. I excluded such categories as "bread and bakery products" and

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[1] These proportions are based on "industry-section" data for the USSR and on US data adjusted to the Soviet definition of industry and to the "industry-section" employment concept.

"confectionery products" because of the great diversity of product-mix and the lack of the data with which to allow for this.

Concerning adjustments for quality, I could make only a few with the time and resources available. To allow for the fact that US fabrics are considerably wider than Soviet fabrics, I measured textile outputs in square meters rather than in linear meters, an adjustment which may account in large part for the differences between Kats' and my ratios. The output of crude petroleum and natural gas is measured in standard fuel equivalents. Although adjustments for quality should also be made for other branches, they cannot easily be made with available data. Rubber footwear is a case in point. A considerable part of rubber footwear output in the US consists of tennis shoes and sneakers, the labor requirements for which are lower than those for rubber boots or galoshes. The output of tennis shoes and sneakers apparently is much smaller relative to the total in the USSR than in the US, but we do not know by how much.

Having sketched a few of the problems of comparing products, I now turn to the comparison of employment. Because the USSR does not publish a detailed breakdown of industrial employment, the employment data for 14 of the 26 branches shown in Table 3 had to be derived from Kats' productivity estimates and official production data from statistical handbooks. I may have erred in matching these data; if so, I wish to be set straight. Presumably, Kats used "labor section" data, which omit employment in cooperatives, in small-scale establishments and in industrial activities classified in non-industrial branches, e.g., in construction. I used the more comprehensive "industry-section" data for the 12 branches for which independent calculations could be made. In some cases the employment data clearly do not correspond exactly to the product data. Thus the employment figures for paper and paperboard include paper products in both countries; data for paper products alone are not avail

The most important difference between the definition of "production worker" in the two countries is the inclusion of junior service personnel, guards, and apprentices in US statistics and their omission in Soviet statistics. Both Kats and I adjusted Soviet data for this difference. If data had permitted, I should also have allowed for the fact that Soviet engineering-technical workers who are working foremen or are engaged in product development are classified as production workers in the US. Neither Kats nor I made allowance for the difference in procedures for measuring employment in the two countries. 1/ The Bureau of Labor Statistics annual employment data, which I used in most cases, are based on the monthly average number of persons who worked or were paid in any part of the pay period ending nearest the 15th of the month. Soviet annual employment data are based on the mean of the monthly averages of daily counts of personnel carried on establishment rolls, including those on leave for a variety of reasons. This difference in measurement procedures probably does not significantly affect the comparability of the data, particularly for recent years, in view of the trend toward greater amounts of paid leave of various kinds in American industry. There are other less important differences in employment concepts and measurement procedures between the two countries, but available data will not permit adjustment for them at the level of individual branches of industry.

Next, we may consider the matter of weights. Kats used Soviet employment and wage bills as weights. Because these Soviet wage bills are not available, my comparisons could be weighted directly only by employment in both countries. Average output per production worker in the USSR is shown to be 28 percent of the US output using Soviet weights and 30 percent using US weights; the unweighted average is 31 percent. Available data would have permitted me to

1/ For coal and iron ore mining, Kats reduced Soviet employment figures by 12 percent for comparison with Bureau of Mines' data for the US.

combine the 26 product groups into 12 or 13 major branches and to weight them with total production workers, total employment, or total wage bills for both countries. Regrettably, my sample is not sufficiently representative to warrant that kind of aggregation.

Finally with respect to the methodological problems involved in extrapolation of these findings concerning levels, I also made some comparisons for 10 of the 26 branches in 1940 and 1950 (Table 4). The estimates for 1940 and 1950 were constructed by using production and employment data defined and measured in the same way as in the estimates for 1956 shown in Tables 1 - 3. The productivity ratios for 1940 agree fairly well with those obtained by Galenson for pre-war years. [1]

The foregoing discussion touches on a few of the many perplexing problems involved in making productivity comparisons for individual branches of industry. The remainder of the paper will consider only one methodological problem on a more aggregative level -- that of obtaining comparable measures of employment in industry as a whole. As we have seen, both Soviet and American economists have used a variety of estimates of the relative levels of industrial employment in the two countries. Obtaining comparability turns out to be a complicated task, however, and only the main considerations can be sketched here. Undoubtedly the most critical problem is to standardize the employment data for difference in the definition of "industry." Because the data needed to adjust Soviet employment data to the US definition are not available, the Western economist must try to adjust US data to conform to Soviet definitions of scope and coverage. [2] To accomplish this, using Bureau of Labor Statistics data, we must add employment in at least the following activities to the total in manu-

[1] Walter Galenson, Labor Productivity in Soviet and American Industry, New York, 1955, p. 241.

[2] If the employment data are adjusted in this manner, comparable adjustments also need to be made in the product data. The Federal Reserve Board's industrial production index covers only manufacturing, mining, and electric and gas utilities.

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facturing, mining, and gas and electric utilities (the groups usually used in US-USSR comparisons): cleaning and dyeing, fluid milk, fishing, refrigerated warehousing and storing, food lockers, railroad shops of railroad lines, auto service and repair shops, motor vehicle repair by dealers and gasoline stations, other repair services of various kinds, water supply, and industrial activities carried on by government enterprises. All of these activities are included within the scope of "industry" in the USSR and not in the US. We must deduct employment in the following activities which would be classified as "industrial" in the US but not in the USSR: publishing; drilling and exploration work; medical and educational services in industry; cafeterias operated by industrial plants; and force account construction work. We also have to subtract from the US data a part of central administration office employment, which would be allocated to administration under Soviet classification procedures. Another deduction ought to be made to allow for the double counting of multiple job-holders in BLS statistics. Finally, since BLS data cover only wage and salary workers, estimates of the number of proprietors have to be added to BLS data in order to obtain comparability with the USSR.

The USSR compiles industrial employment statistics on two different bases, termed "industry-section" statistics and "labor-section" statistics. The former are the more comprehensive, because (1) they include employment in many small-scale industrial establishments not covered in the latter, (2) they include employment in industrial activities carried on by establishments whose major activity is classified as non-industrial (e.g., a brickmaking plant of a State farm), and (3) they include all employment in industrial cooperatives and in subsidiary industrial enterprises of collective farms. However, the USSR "industry-section" statistics cover only wage workers and their equivalents in industrial cooperatives and on collective farms.

Which of these two employment concepts should be used in comparisons with the US? I am inclined to favor the "industry-section" concept, because it is more comprehensive and therefore would include types of employment that also would be included in the adjusted US industrial employment statistics. Unfortunately these data have not been published in detail since 1933 and only as an aggregate for 1935. In the postwar statistical handbooks only percentage distributions of employment by branch of industry have been presented for selected years, up to and including 1956. Since then only percentage distributions of total industrial employment by republics are shown in the handbooks on the national economy. Therefore, one has to compute "industry-section" employment estimates from published "labor-section" statistics and other data. If "labor-section" data are used to compare with the US, one at least ought to add employment in industrial cooperatives and also independent artisans to these statistics.

In conclusion, I should like to give a few figures showing the USSR/US employment ratios that are obtained for 1940, 1950, 1956, and 1958 when US data are adjusted for comparability (as described above) with both "industry-section" and "labor section" statistics for the USSR. [1] Also I shall give the ratios that are obtained by simply comparing USSR figures for workers and employees in industry with US figures for total employment in mining, manufacturing and electric and gas utilities, as is commonly done. By all three measures the ratios for 1940, 1950, and 1956 differ greatly from those for

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[1] The sources and methodology underlying these estimates are described in detail in: Murray S. Weitzman, "Comparison of US and USSR Employment in Industry," US Bureau of the Census, International Population Reports, Series P-95, No. ___ (forthcoming).

1958. The higher ratios for 1958 reflect the sharp drop in industrial employment in the US in 1958, a recession year.

Relative Levels of Total Industrial Employment,
US and USSR; Selected Years 1940-58
(US=100)

	1940	1950	1956	1958
Alternative A	90	86	101	117
Alternative B	105	89	100	115
Alternative C	115	99	111	125

Alternative A:

US -- Bureau of Labor Statistics data for total employment in manufacturing, mining, and electric and gas utilities.

USSR -- Workers and employees in industry ("labor-section" concept).

Alternative B:

Bureau of Labor Statistics data adjusted to USSR "labor-section" concept, including members of industrial cooperatives and independent artisans.

Alternative C:

Bureau of Labor Statistics data adjusted to USSR "industry-section" concept, including members of industrial cooperatives, employment in collective farm industry, and independent artisans.

Table 1

Physical Output per Production Worker
in Selected Industries
US and USSR, 1956

| | | Output per Worker | | Ratio |
	Units	US	USSR	(US=100)
Coal	Metric Tons	2,036	400	20
Coke	Metric Tons	2,314	793	34
Crude Petroleum and Natural Gas	Metric Tons of Std. Fuel Equiv.	5,414	1,089	20
Petroleum Refining	Metric Tons	2,886	1,049	36
Iron Ore	Metric Tons	3,271	1,101	34
Pig Iron, Steel, Rolled Prod.	Metric Tons	480.6	211.9	44
Synthetic Rubber	Metric Tons	156.7	19.4	12
Artificial Fiber	Metric Tons	15.0	2.6	17
Rubber Footwear	Pairs	5,051	3,756	74
Electric Power	1,000 KWH	3,118.4	582.5	19
Paper and Paperboard	Metric Tons	61.6	21.8	35
Lumber and Logging	Cubic Meters	908.6	226.6	25
Cement	Metric Tons	1,530	527.8	34
Brick	1,000 Pieces	255.0	67.7	27
Lime and Gypsum	Metric Tons	1,077	260.8	24
Cotton Fabrics	Square Meters	24,838	5,798	23
Silk and Synthetic Fabrics	Square Meters	22,524	6,164	27
Woolen Fabrics	Square Meters	4,377	1,815	41
Footwear (Except Rubber)	Pairs	2,672	1,046	39
Beer	Decaliters	20,196	7,077	35
Sugar	Metric Tons	86.4	33.9	39
Flour	Metric Tons	503.5	251.4	50
Meat	Metric Tons	50.1	19.4	39
Dairy Products	Metric Tons	391.3	115.5	30
Margarine	Metric Tons	337.8	56.95	17
Motor Vehicles	Vehicles	10.67	2.29	21

Sources: Tables 2 and 3.

Table 2

Output per Production Worker
in Selected Industries,
US, 1956

Branch of Industry	Output		Production Workers (000)	Output per Production Worker	
	Level	Units		Level	Units
Coal	479,696	1,000 M.T. a/	235.6	2,036	M.T.
Coke	67,570	1,000 M.T.	29.2	2,314	M.T.
Crude Petroleum and Natural Gas	848,376	1,000 M.T. b/	156.7	5,414	M.T. b/
Petroleum Refining	378,100	1,000 M.T.	131.0	2,886	M.T.
Iron Ore	99,448	1,000 M.T.	30.4	3,271	M.T.
Pig Iron, Steel, Rolled Prod.	255,981	1,000 M.T.	532.6	480.6	M.T.
Synthetic Rubber	1,097	1,000 M.T.	7.0	156.7	M.T.
Artificial Fiber	746.0	1,000 M.T.	49.6	15.0	M.T.
Rubber Footwear	100,007	1,000 Pairs	19.8	5,051	Pairs
Electric Power	684,804	Mil. KWH	219.6	3,118.4	000 KWH
Paper and Paperboard	28,523	1,000 M.T.	463.4	61.6	M.T.
Lumber and Logging	408.4	Mil. M3	449.5	908.6	M3
Cement	56,152	1,000 M.T.	36.7	1,530	M.T.
Brick	8,085	Mil. Pieces	31.7	255.0	000 Pieces
Lime and Gypsum	18,954	1,000 M.T.	17.6	1,077	M.T.
Cotton Fabrics	10,094	Mil. M2	406.4	24,838	M2
Silk and Synthetic Fabrics	2,588	Mil. M2	114.9	22,524	M2
Woolen Fabrics	460	Mil. M2	105.1	4,377	M2
Footwear (Ex. Rubber)	591.8	Mil. Pairs	221.5	2,672	Pairs
Beer	1,064	Mil. Decal.	52.7	20,196	Decal.
Sugar	2,280	1,000 M.T.	26.4	86.4	M.T.
Flour	10,422	1,000 M.T.	20.7	503.5	M.T.
Meat	13,470	1,000 M.T.	268.8	50.1	M.T.
Dairy Products	28.2	Mil. M.T. c/	72.1	391.3	M.T.
Margarine	621.6	1,000 M.T.	1.84	337.8	M.T.
Motor Vehicles	6,920,600	Vehicles	648.5	10.67	Vehicles

a/ M.T. - metric tons.
b/ In standard fuel equivalents.
c/ Milk equivalent of manufactured dairy products.

Sources:

Output: All data from United Nations, Statistical Yearbook 1959, except:

(1) Iron ore, paper and paperboard, lime and gypsum, silk and synthetic fabrics, meat, and dairy products -- from Statistical Abstract of the United States, 1958 and 1959.

(2) Artificial fiber -- from Textile Organon, February 1957, p. 18.

(3) Lumber and logging -- from United Nations, Yearbook of Forest Product Statistics, 1958, pp. 36-7. 64.

(4) Steel -- from United Nations, Statistical Yearbook, 1959 and Statistical Abstract of the United States, 1959.

(5) Petroleum refining -- O.E.E.C., Industrial Statistics, 1900-59, Paris, 1960, p. 67.

(6) Rubber footwear -- US Census of Manufactures, 1954. Extrapolated to 1956 on the basis of the change in employment, 1954-56.

Employment: All data from US Bureau of Labor Statistics, Employment and Earnings, Vol. 6, No 11 May 1960, except:

(1) Coke -- estimated from data in the US Census of Manufactures, 1954 and Statistical Abstract of the United States, 1959.

(2) Synthetic rubber, artificial fiber, lime and gypsum, brick, cotton fabrics, silk and synthetic fabrics, woolen fabrics, beer and flour -- from Annual Survey of Manufactures, 1956.

(3) Margarine -- from US Census of Manufactures, 1954.

(4) Crude petroleum and natural gas -- Bureau of Labor Statistics figure for production workers in "Crude Petroleum and Natural Gas Production," less an estimated number engaged in well drilling and rig building. See Demitri B. Shimkin, The Soviet Mineral Fuels Industries, 1927/28-1958, US Bureau of the Census (to be published in International Population Reports, Series P-95), p. 52.

Table 3

Output per Production Worker in Selected Industries, USSR, 1956

Branch of Industry	Output Level	Units	Production workers (000)	Output per Production Worker Level	Units
Coal	429,174	1,000 M.T. a/	1,073.4	400	M.T.
Coke	46,600	1,000 M.T.	58.8	793	M.T.
Crude Petroleum and Natural Gas	134,323	1,000 M.T. b/	123.4	1,089	M.T. b/
Petroleum Refining	75,200	1,000 M.T.	71.7	1,049	M.T.
Iron Ore	78,079	1,000 M.T.	70.9	1,101	M.T.
Pig Iron, Steel, Rolled Prod.	122,285	1,000 M.T.	577.0	211.9	M.T.
Synthetic Rubber	N.A.			19.4	M.T.
Artificial Fiber	128.9	1,000 M.T.	49.7	2.6	M.T.
Rubber Footwear	145,000	1,000 Pairs	38.6	3,756	Pairs
Electric Power	179,453	Mil. KWH	308.1	582.5	000 KWH
Paper and Paperboard	2,581	1,000 M.T.	118.5	21.8	M.T.
Lumber and Logging	427.5	Mil. M3	1,886.4	226.6	M3
Cement	24,858	1,000 M.T.	47.1	527.8	M.T.
Brick	21,566	Mil. Pieces	318.6	67.7	000 Pieces
Lime and Gypsum	13,455	1,000 M.T.	51.6	260.8	M.T.
Cotton Fabrics	4,366	Mil. M2	753.0	5,798	M2
Silk and Synthetic Fabrics	617	Mil. M2	100.1	6,164	M2
Woolen Fabrics	341	Mil. M2	187.9	1,815	M2
Footwear (Ex. Rubber)	311.2	Mil. Pairs	297.5	1,046	Pairs
Beer	180.7	Mil. Decal.	25.5	7,077	Decal.
Sugar	4,714	1,000 M.T.	139.0	33.9	M.T.
Flour	32,000	1,000 M.T.	127.3	251.4	M.T.
Meat	2,671	1,000 M.T.	137.5	19.4	M.T.
Dairy Products	17.3	Mil. M.T. c/	149.8	115.5	M.T.
Margarine	437	1,000 M.T.	7.7	56.95	M.T.
Motor Vehicles	464,632	Vehicles	203.3	2.29	Vehicles

a/ M.T. - metric tons.
b/ In standard fuel equivalents.
c/ Milk equivalent of manufactured dairy products.

Sources:

Output: All data from Narodnoye khozyaystvo SSSR v 1959 godu except:

(1) Petroleum refining -- Demitri B. Shimkin, The Soviet Mineral Fuels Industries, 1927/28-1958, US Bureau of the Census, (to be published in International Population Reports, Series P-95), p. 112.

(2) Coke -- Narodnoye khozyaystvo SSSR v 1958 godu.

(3) Dairy products -- V. P. Zotov, Pishchevaya promyshlennost' sovetskogo soyuza, p. 161.

Employment: All data derived from officially reported output data and output per worker given by A. Kats, Sotsialisticheskiy trud no 1, 1959, p. 46. except:

(1) Coal, coke, petroleum refining, iron ore, steel, electric power, and lumber and logging -- from Murray S. Weitzman and Andrew Elias, The Magnitude and Distribution of Civilian Employment in the USSR: 1928-59, US Bureau of the Census, International Population Reports, Series P-95, no 57, pp. 71-72, 74.

(2) Crude petroleum -- Figure for 1955 taken from Demitri B. Shimkin, The Soviet Mineral Fuels Industries, 1927/28-1958, p. 103 and extended to 1956 with data in Murray S. Weitzman and Andrew Elias, op. cit., p. 74.

(3) Paper and paperboard -- Figure for 1955 taken from Murray S. Weitzman and Andrew Elias, op. cit., p. 72 and extended to 1956 with production and productivity data in Narodnoye khozyaystvo SSSR v 1958 godu, p. 139 and Narodnoye khozyaystvo SSSR v 1959 godu, p. 154.

(4) Cement -- Estimated from production and productivity data in Narodnoye khozyaystvo SSSR v 1958 godu, p. 259 and Z. I. Loginov, Tsementnaya promyshlennost' SSSR i perspektiviy yeye razvitiya, p. 111.

(5) Sugar (figure for 1955) -- from V. P. Zotov, Pishchevaya promyshlennost' sovetskogo soyuza p. 57.

(6) Motor vehicles -- from Barney K. Schwalberg, Manpower Utilization in the Soviet Automobile Industry, US Bureau of the Census, International Population Reports, Series P-95, no 53, p. 31. His estimate for 1955 extrapolated to 1956 at average annual numerical increase for 1950-55.

(7) For coal, coke, crude petroleum and natural gas, petroleum refining, iron ore, steel, paper, lumber and logging, electric power, cement, motor vehicles, and sugar -- an estimate of the number of apprentices, guards, and junior service personnel (MOP) was added to the number of workers (rabochiye) obtained as indicated above. These estimates were based on data in V. Ye. Komarov, Ekonomicheskiye osnovy podgotovki spetsialistov dlya narodnogo khozyaystva, p. 70 and Demitri B. Shimkin, Notes on the Industrial Labor Force of the Soviet Union, US Bureau of the Census, Foreign Manpower Research Office, July 1958 (ditto).

Table 4

Percent Change in Output per Production
Worker 1940-56, and Levels of Productivity
1940, 1950 and 1956
US and USSR

| | Percent Change in Output per Production Worker | | | | USSR Level of Productivity (US=100) | | |
| | US | | USSR | | | | |
	1940-56	1950-56	1940-56	1950-56	1940	1950	1956
Coal	118	65	32	31	33	25	20
Coke	26	20	33	29	32	32	34
Iron Ore	4	5	25	39	28	26	34
Pig Iron, Steel, Rolled Prod.	51	19	57	44	42	36	44
Electric Power	234	79	78	55	36	22	19
Lumber and Logging	--	25	--	22		26	25
Paper and Paperboard	30	15	28	48	36	27	35
Cement	58	33	152	97	21	23	34
Motor Vehicles	10	-7	55	-2	15	20	21
Footwear (Ex. Rubber)	45	--	5	--	54		39

Sources:

US
Output Indexes -- All output data from Statistical Abstract of the United States,
1958 and 1959 and Historical Statistics of the United States except:
   (1) Logging -- UN, FAO, European Timber Statistics 1913-50, Table P-2; and UN, FAO,
      Yearbook of Forest Product Statistics, 1958, pp. 36-37.
   (2) Motor Vehicles -- Automotive Industries, Vol. 122, no 6, March 15, 1960, p. 79.
   (3) Footwear -- National Shoe Manufactures' Association, Facts and Figures for
      Footwear, 1958, p. 17.
  Employment Indexes -- All employment data are published and unpublished estimates of
the Bureau of Labor Statistics except those for coke, which are from the Bureau of Mines.
Published data are from Statistical Abstract of the United States, 1958 and BLS, Employment
and Earnings, Vol. 6, no 11, May 1960.

USSR
Output Indexes -- All output data from Narodnoye khozyaystvo SSSR v 1958 godu and
Narodnoye khozyaystvo SSSR v 1959 godu.
  Employment Indexes -- Production worker estimates are published and unpublished
estimates of the Foreign Manpower Research Office. Estimates of the number of wage
workers (rabochiye) are set forth principally in Murray S. Weitzman and Andrew Elias,
The Magnitude and Distribution of Civilian Employment in the USSR, 1928-59. US Bureau of
the Census, International Population Reports, Series P-95, no 57, Table 7. Estimates of
the number of apprentices, junior service personnel, and guards, added to the estimates
for wage workers, are based on Narodnoye khozyaystvo SSSR v 1959 godu, p. 138 and
V.Ye. Komarov, Ekonomicheskiye osnovy podgotovki spetsialistov dlya narodnogo khozyaystva,
Moscow, 1959, p. 70.